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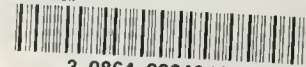
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Montana's Energy Resources

VOLUME
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To many Montanans, winter brings with it not only icy temperatures, but also high home heating bills. This is especially true in the Tobacco Root Mountains southeast of Butte, where Pete Gross makes his home. But while many of his neighbors are busy chopping wood or mentally preparing for high home heating bills, Pete is unconcerned. His 2,300-sq. ft. log home, snowed in for much of the winter, remains a comfortable 65°-70°F year-round. And Pete doesn't pay a penny for fossil fuel, or worry about stocking up on firewood. Instead, when the weather starts to turn chilly in the fall, Pete simply opens a valve on the side of his home. Geothermal water, warmed by the natural heat of the earth's interior, then flows through plastic pipes buried in his home's concrete floor slab. This clean, renewable energy heats the slab, which in turn warms the home and keeps Pete and his family comfortable during Montana's long winters.

Pete Gross isn't the only Montanan using geothermal energy. Homeowners and businessmen throughout the state have discovered that geothermal can be used to reduce their heating bills. More than a dozen businesses and homes in Montana use geothermal water to provide most of their heat. These buildings include a greenhouse near Helena

that is warmed by a naturally heated 85°F hot spring, and a bank in White Sulphur Springs heated with geothermal water pumped from a deep well.

So how might geothermal energy fit into your life? Would you like to be able to sit back, relax, and let Mother Nature provide you with free utilities? Unfortunately, it's not that easy. There just aren't enough geothermal resources in Montana to let us all stop paying our monthly heating bills. But even if you don't intend to buy a hot spring or drill your own hot water well, you may be interested in knowing how geothermal energy is used for heating purposes.

Four major factors must be considered before you undertake a geothermal heating project:

- 1) Finding a geothermal resource and establishing ownership
- 2) Piping geothermal fluid to your home or business
- 3) Using the proper heating equipment
- 4) Disposing properly of the spent geothermal fluid

We'll discuss these four factors in the following sections of this brochure.



GEOTHERMAL RESOURCES OF MONTANA

MONTANA'S GEOTHERMAL RESOURCES

Several thousand miles beneath Montana, the earth's core is surrounded by molten rock (called magma) with temperatures approaching 6,000 °F. We are protected from these extreme temperatures by the insulating soil and rock between the earth's crust and the magma. Even Montana's groundwater, hundreds to thousands of feet below us, remains a cool 45 °-50 °F year-round. However, in certain parts of Montana, there are deep cracks, or fault lines, in the earth. Groundwater that finds its way into these fault lines circulates much deeper than most water, and comes into contact with much warmer areas of the earth's interior. If this warmed groundwater encounters another fault line, it may move upwards to the earth's surface, where it emerges as a hot spring.

borders, in areas as diverse as Colstrip, Jordan, Anaconda, and, of course, the town of Hot Springs south of Kalispell. Most hot springs in Montana are found in the mountain valleys in the southwestern portion of the state, where many fault lines occur. Another area with lots of geothermal potential exists in eastern Montana, where deep groundwater aquifers may be tapped by drilling hot water wells.

Well drillers occasionally hit hot water by accident, as has happened several times in the eastern Montana oilfields. More often, geologists assist in determining where geothermal wells should be drilled. Many of the same techniques used in discovering oil and gas are used to find geothermal deposits: seismic soundings, gravity measurements, resistivity, and test drilling have all been used.

Flow rates for Montana's geothermal resources vary from a few gallons per minute to almost 2,000 gallons per minute of artesian hot water that flows from a geothermal well near Bozeman. Temperatures range from slightly warmer than groundwater (45 °-55 °F) up to 180 °F. Geothermal wells in eastern Montana can be even hotter than our naturally occurring hot springs. One of the hottest wells in Montana, located near Poplar, has a temperature that exceeds 240 °F.

In spite of the large number of hot springs and hot water wells in the state, Montana does not have an unlimited supply of either hot geothermal or cold ground- or surface water. The state has developed a water rights allocation system to track what water is being used, and to determine if sufficient water is available for additional development. Before you start drilling a geothermal well or using a hot spring for heating, you must obtain a water rights permit from the Montana Department of Natural Resources and Conservation.

TRANSPORTING GEOTHERMAL ENERGY

Before you can use your geothermal resource for heating, you must pipe the hot water from the well or spring to your home or business. More than a century ago, wooden pipelines were used to transport geothermal water. Remains of these pipelines can be found near some of Montana's early-day hot springs resorts. Today, wood is rarely the preferred material for geothermal piping. Instead, various types of plastic, adapted to specific temperature ranges, are used. Among the materials used are polyethylene, polybutylene, PVC and CPVC. For extremely hot water (over 200 °F), carbon steel piping is used.

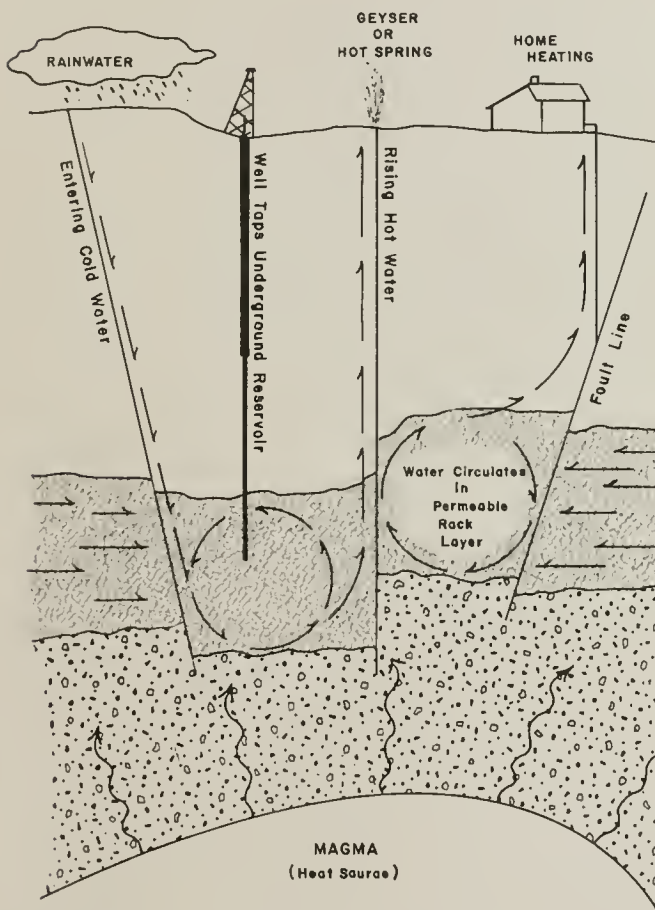


Figure 2. Deep Circulation of Geothermal Water

Our state has many hot springs. Yellowstone National Park, with its numerous geysers, boiling mud pots, and other geothermal features, is certainly the most visible evidence of geothermal energy in our area. However, more than a hundred hot springs and hot water wells are located within Montana's

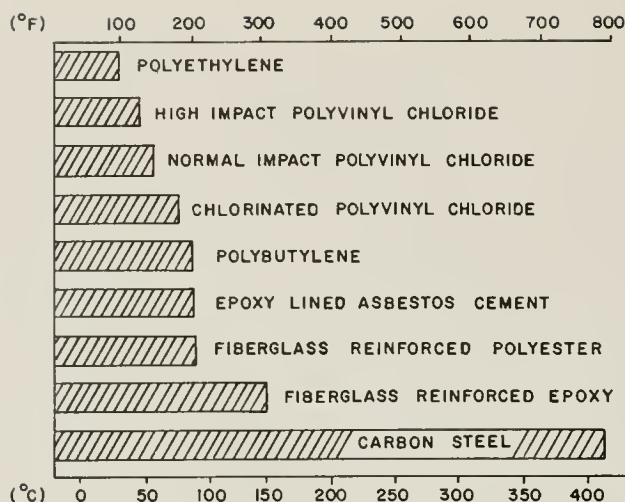


Figure 3. Temperature Ranges for Piping Materials

Water quality can also affect the type of piping used for a geothermal system. Many geothermal wells and hot springs in Montana contain large quantities of minerals and gases (including hydrogen sulfide, the "rotten egg" gas you may have smelled in Yellowstone National Park). These contaminants can cause corrosion or sedimentation in geothermal piping. To prevent this from happening, a device called a "heat exchanger" is sometimes used. This consists of a series of stainless steel plates, with the dirty geothermal water on one side of the plate and clean cold water on the other side of the plate. The geothermal water exchanges its heat through the plate to the clean water, which is in turn warmed. The heated clean water can then be used in the piping and heating system. The Broadwater Athletic Club near Helena uses a heat exchanger to warm clean municipal water, which is then used in swimming pools, whirlpools, and the hot water system.

Geothermal piping is often insulated to prevent heat loss from the pipe before the water reaches its end use. The simplest insulating method is burying the bare pipe in the ground. Sometimes insulating foam is blown around the pipe before it's buried, or rigid insulation is installed around the pipe during manufacturing. A well insulated geothermal pipeline can transport geothermal water for several miles without losing more than one or two degrees F per mile. The cost of the piping may be one of your biggest expenses in developing a geothermal resource. Be sure that the piping material selected and the insulation method used are the best suited for your particular application.

HEATING METHODS WITH GEOTHERMAL

By far the greatest potential that geothermal energy holds for Montanans is space heating. Geothermal resources as cool as 85 °F are being used to heat Montana homes, greenhouses, and commercial buildings. However, this isn't the lower temperature limit of geothermal's potential. Devices called groundwater heat pumps can pull energy out of water as cold as that from your cold water tap (around 45 °F).

If geothermal water is available in the 85 °F range upwards, it can be used directly for heating without using a heat pump. Four direct heating methods can be used, depending on the water temperature. When geothermal water over 85 °F is available, radiant slab heating works well. Plastic or metal piping is laid in a concrete floor as it is poured, a few inches beneath the floor surface. Geothermal water is then pumped through the piping, warming the floor, and heating the space above. The Hillbrook Nursing Home in Alhambra uses this type of geothermal heating system, as does the Pete Gross home in the Tobacco Root Mountains.

Geothermal water above 105 °F can be used in a forced air system similar to a natural gas furnace. In this heating system, the water is piped through a series of finned tubes resembling a car radiator placed inside the plenum of a gas or electric furnace. The furnace fan forces cold air through the heated finned tubes, warming the air, which then blows through the furnace ducts into the house. Quinn's Hot Springs Resort north of Missoula and the Broadwater Athletic Club near Helena both use forced air geothermal systems.

If the water is warmer than 140 °F, finned tubes may be placed along the walls of a room. Geothermal water then flows through the tubes, heating the fins which radiate heat into the room. Cooler water temperatures also work in this system, but the length of finned tubes required to comfortably heat a space increases dramatically if cooler geothermal temperatures are used.

Finally, geothermal water warmer than 160 °F can be used in the old-style cast-iron radiators. You're probably familiar with this type of heating system in many older steam-heated buildings. Although this is the least efficient method of using geothermal heat, it has been used for more than a hundred years in some of the old hotels built near Montana's hot springs, such as the Diamond S Hotel near Boulder.

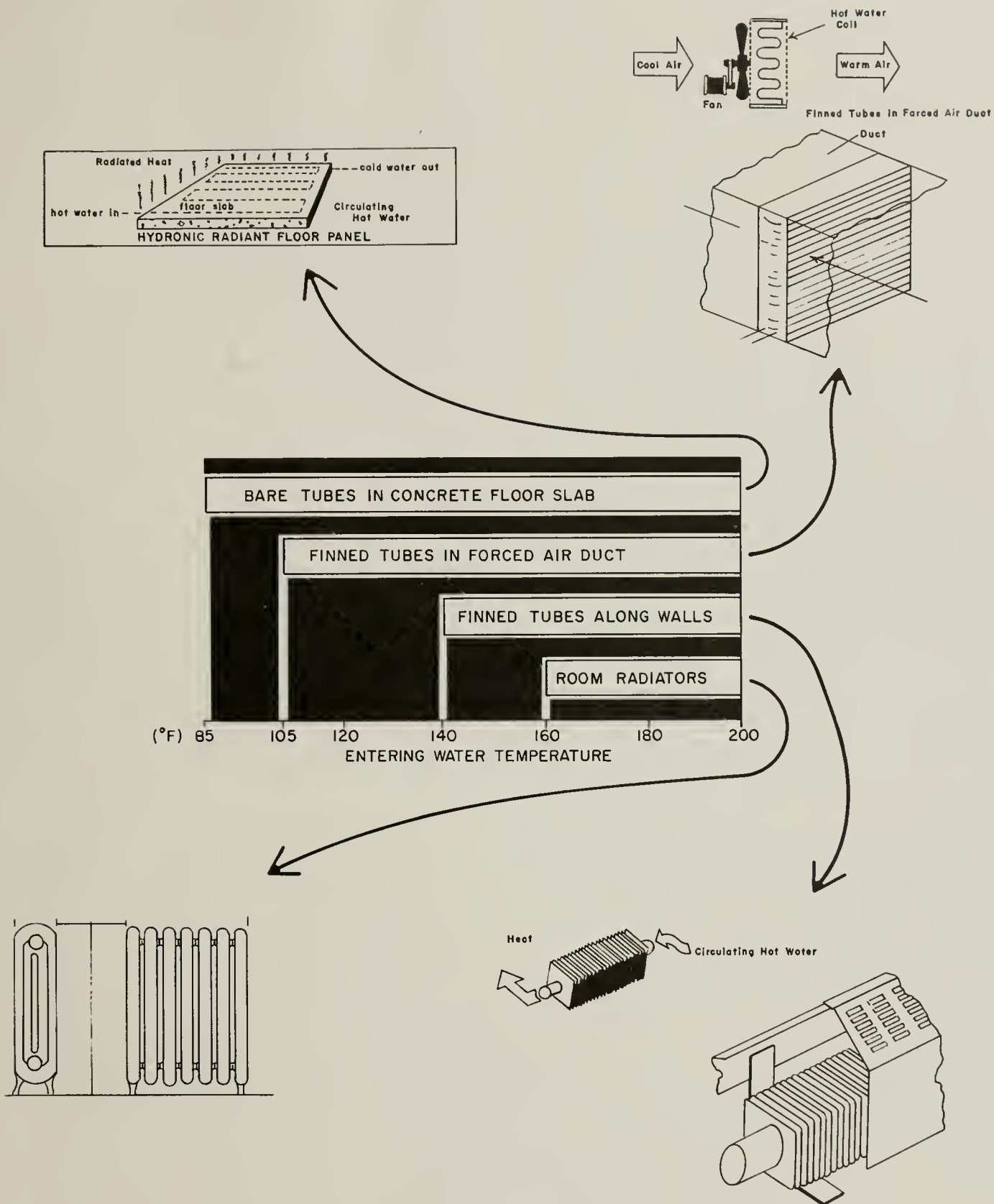


Figure 4. Geothermal Heating Systems

The flow rate required for heating a building varies with the temperature of the water. In general, the warmer the geothermal water, the less flow is needed. For example, a 1,000-sq. ft. home in western Montana might require 14 gallons per minute of 85°F water in a radiant slab heating system, but would only need 2 gallons of 140°F water to heat the same building with a finned tube heating system.

No matter what type of heating system you are considering, conservation is almost always a good first step. Weatherstripping, caulking and insulating a structure will make your home feel more comfortable and will require less geothermal energy than a poorly insulated structure. Do a careful analysis of exactly how much energy you need before you invest in geothermal energy equipment—it may turn out that a combination of conservation and solar energy may be a better investment.

WASTE DISPOSAL

After you've heated your home or business with geothermal energy, you're faced with one final problem—what do you do with the spent geothermal water? This water often contains a high percentage of minerals, and may have an elevated temperature that could thermally pollute Montana's lakes, streams, and groundwater supplies. Proper disposal of the spent geothermal fluid is needed to help maintain the high quality of our state's water. You have three options when considering geothermal

waste disposal: surface discharge, discharge to an artificial impoundment, or reinjection into an aquifer. The method you select for disposing of the used geothermal water will depend both on environmental considerations and on economics. The Montana Department of Health and Environmental Sciences requires permits for any surface discharge or reinjection of geothermal water; contact them before you decide on your disposal method.

CONCLUSION

Even though a number of successful geothermal heating projects are operating in Montana, we've only started to tap the enormous energy potential of the earth's natural heat. A variety of new geothermal projects have been proposed for our state, including raising catfish in warm water ponds, providing process heat for an ethanol plant, and inexpensively heating hundreds of homes through a district heating system.

Perhaps you've got your own ideas on how to use geothermal energy and would like to know more about adapting it to your own project. If so, you may want to write for some of the following geothermal publications. But even if your only contact with geothermal is soaking in a hot springs on a frosty winter evening with snow falling on your ears, Montana's geothermal resources will have proved their value.

FOR MORE INFORMATION

“Direct Utilization of Geothermal Energy: A Technical Handbook” available from the Geothermal Resources Council, Box 98, Davis, CA 95617. Price—\$10.00

“Geo-Heat Center Quarterly Bulletin” available from the Oregon Institute of Technology, Klamath Falls, OR 97601. A quarterly report on the direct utilization of geothermal, emphasizing western U.S. applications. Subscriptions are free.

“Geothermal Resources Council Bulletin” available from the Geothermal Resources Council, P.O. Box 98, Davis, CA 95617. \$45.00 per year.

“Geothermal Energy” A monthly newsletter, available from Geothermal World, 5762 Firebird Court, Mission Oaks, Camarillo, CA 93010. \$45.00 per year.

“Ground Water Energy Newsletter” available from NWWA, 500 W. Wilson Bridge Road, Suite 130, Worthington, OH 43085. \$8.00 per year.

“Geothermal Resources Map of Montana—HM4” available from the Montana Bureau of Mines and Geology, Butte, MT 59701. \$1.00 for handling and shipping.

TECHNICAL ASSISTANCE

Questions concerning water rights applications should be directed to the Water Rights Bureau, Montana Department of Natural Resources and Conservation, Capitol Station, Helena, MT 59620, or call (406) 444-6754.

Waste disposal and reinjection questions should be directed to the Department of Health and Environmental Sciences, Water Quality Bureau, Capitol Station, Helena, MT 59620, or call (406) 449-2406.

For information on geology, hydrology, and well drillings, contact the Montana Bureau of Mines and Geology, Department of Hydrology, Butte, MT, or call (406) 496-4166.

Technical assistance for geothermal heating system design and information on energy grants and loans is available from the Energy Division, Department of Natural Resources and Conservation, Capitol Station, Helena, MT 59620, or call (406) 444-6746, or 444-6696.



The use of Montana's geothermal resources is not new. The Broadwater Natatorium near Helena, built in 1890, was heated entirely by a bubbling hot spring. "The World's Largest Plunge", this magnificent structure has long since been torn down. However, the geothermal resource is still around, heating the modern Broadwater Hot Springs and Athletic Club. (Photo courtesy of the Montana Historical Society).

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